Environmental Regulation and Development: A Cross-Country Empirical Analysis

by

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1. Introduction

The past few years have witnessed the rapid growth of research on the relationship between economic development and environmental quality. Gruver (1976), John and Pecchenino (1994), Lopez (1994), Selden and Song (1995), John et. al. (1995) and McConnell (1997) have done theoretical work on the relations linking income growth, pollution, regulation and abatement effort. This work has shown that an 'Environmental Kuznets Curve' (EKC) -- an inverted-U relation in which pollution first rises and then falls as income increases -- can result if a few plausible conditions are satisfied as income increases: Constant or falling marginal utility of consumption; rising marginal disutility of pollution; constant or rising marginal pollution damage; and rising marginal abatement cost.

Most econometric work on EKC relations has been reduced-form in character, regressing cross-country measures of ambient air and water quality on quadratic or higher-order specifications of income per capita (Hettige, et. al., 1992; Shafik and Bandyopadhyay, 1992; Panayotou, 1993, 1995; Shafik, 1994; Selden and Song, 1994; Grossman and Krueger, 1995; Holtz-Eatkin and Selden, 1995; Rock, 1996; Horvath, 1997; Cole et. al., 1997; Stern et. al., 1998). The results are generally consistent with an EKC for air pollutants such as suspended particulates and sulfur dioxide, although results for water pollution are mixed. In most cases, the implied relationship is sensitive to inclusion of higher-order polynomial terms in income whose significance varies widely. In one of the most comprehensive reviews of the empirical literature on the EKC hypothesis, Stern (1998) argues that the evidence on the inverted-U relationship only applies to a subset of environmental measures and that other pollution problems increase through the existing income range. For example, Stern, et. al. (1998) find a monotonic increasing relation

between sulfur emissions and income per capita.

Structural interpretation of reduced-form EKC results remains largely ad hoc, since data limitations have prevented detailed investigation of the sources of change in the marginal relationship between development and pollution. In a recent paper, Panayotou (1997) has attempted to estimate the impact of environmental regulation. Lacking actual measures of regulation, however, he uses indices of contract enforcement and bureaucratic efficiency as proxies. His main finding, at least for ambient SO_2 levels, is that the regulatory proxies are significantly associated with a flattening of the EKC and a reduction in the environmental cost of growth.

It has become clear that structural modeling of the income-environment relationship cannot advance much further without explicit measures of environmental policy. In this paper, we construct such measures and assess their relationship to socioeconomic development. Our information source is the set of environmental reports presented to the United Nations Conference on Environment and Development (UNCED, 1992) by 145 countries. The reports are comparable because the UN imposed a standard reporting format. Using a multidimensional survey of 31 national UNCED reports, we have developed a set of comparative indices for the status of environmental policy and performance. This paper describes our methodology, the indices, and some results from a statistical analysis of their relationship to other more conventional measures of socioeconomic development. In the following section, we begin with a description of the UNCED reports. Section 3 explains our indexing method, while Section 4 sets out some preliminary hypotheses about the relationships linking environmental policy and performance to socioeconomic development. Section 5 reports and discusses some statistical

tests of the hypotheses and Section 6 concludes the paper.

2. The UNCED Reports

As part of the preparations for the United Nations Conference on Environment and Development (UNCED - Rio de Janeiro, June 1992), all UN member governments were asked to prepare national environmental reports. Detailed preparation guidelines were laid down at the First Preparatory Committee meeting in Nairobi in August, 1990.[1] The UNCED secretariat suggested that the reports be prepared by working groups representing government, business and non-governmental organizations (NGO's). The guidelines recommended that the reports provide information on: (i) the drafting process; (ii) problem areas; (iii) past and present capacity building initiatives; (iv) recommendations and priorities for environment and development; (v) financial arrangements and funding requirements; (vi) environmentally sound technologies; (vii) international cooperation; and (viii) expectations about UNCED.

The resulting reports are similar in form as well as coverage and permit cross-country comparisons. Undoubtedly, the participation of NGO's has helped assure that the UNCED reports are not mere government handouts. To a striking degree, they seem to reflect real environmental conditions and issues. While we recognize that self-reporting always carries the risk of misrepresentation, we should also note that almost all currently-available environmental information is self-reported by firms and governments. The UNCED reports differ principally in the absence of any formal sanction for misreporting.

[1] United Nations General Assembly documents A/CONF.151/PC/8 and A/CONF.151/PC/8/Add.1

3. Quantifying Environmental Performance

For this exercise, we have randomly selected 31 UNCED reports from the total of 145 (see Table 2A, p. 8). The 31 reporting countries range from highly industrialized to extremely poor, they are drawn from every world region, and they vary in size and diversity from China to Jamaica.

Our survey assesses the scope and impact of environmental policy in four dimensions: Air, Water, Land and Living Resources. We analyze the apparent state of policy as it affects the interactions between these four environmental dimensions and five activity categories: Agriculture, Industry, Energy, Transport and the Urban Sector. Although many overlaps undoubtedly exist, we attempt to draw a separate assessment for the interaction of each activity category with each environmental dimension.

Our survey assessment uses twenty-five questions to categorize the state of (i) environmental awareness; (ii) scope of policies adopted; (iii) scope of legislation enacted; (iv) control mechanisms in place; and (v) the degree of success in implementation.[2] The status in each category is graded High, Medium or Low, with assigned values of 2, 1 and 0 respectively. For each UNCED country report, all twenty-five questions are answered for each element of the matrix in Table 1. With 20 elements in the matrix, 500 assessment scores are developed for each country.

[2] All country scores are available on request.

Table 1
Evaluation Format

Sector/ Activity	Air	Water	Land	Living Resources
Agriculture				
Industry				
Energy				
Transport				
Urban				

The survey instrument is included in Appendix B. Our questions in the first assessment category (Awareness) reflect recent findings that citizen awareness is a powerful determinant of the strength of environmental regulation (Dasgupta and Wheeler, 1996). The three questions in this category gauge the strength of awareness by asking about its history and extent. Questions in the next two categories, Policy and Legislation, are largely self-explanatory. In the section on Control Mechanisms, we give high ratings to countries that use market-based regulatory instruments such as pollution charges, because recent research has shown them to be very cost-effective in regulating pollution (Wheeler, et. al., 1999). Similarly, we assign high ratings to more decentralized systems because recent research has suggested that they respond more efficiently to local environmental problems (Wang and Wheeler, 1996; Laplante, et. al., 1996). Research has also demonstrated the power of local communities, often acting through NGO's, to influence polluters even when formal regulation is absent or ineffective (Pargal and Wheeler, 1996; Afsah and Vincent, 1997; Blackman and Bannister, 1998). For this reason, we give a high rating to countries where NGO involvement is reported as extensive. Our questions in Measures

of Success are highly varied, enabling us to include both direct measures of environmental performance and factors which affect the public's ability to bring pressure on polluters through channels other than formal regulation (e.g., environmental data availability, interest in environmental studies, level of media interest).

We compute four composite indices by adding scores within each environmental dimension (Air, Water, Land and Living Resources). We also calculate a total score to provide a composite index of the scope and impact of environmental policy. Finally, we use our scoring system to establish separate indices for three particularly interesting policy dimensions: the extent of environmental awareness, enactment of policies, and success in implementation. We use all three sets of indices for the cross-country analysis reported in Section 5.

Using the four dimensional indices and a composite index, we summarize our results as country rankings in Table 2A. Actual values are displayed in Table 2B. Table 2A also ranks countries on the basis of per capita GNP (PCGNP) and per capita GDP estimates compiled by the UN International Comparisons Program (ICPGDP). The ICPGDP computation adjusts the standard income data to take account of purchasing power parity. Where countries in our sample are not covered in the International Comparisons Program Study (Phase V, 1985), we have adopted a World Bank estimate. The 1985 figures have been extrapolated to 1990 using World Bank estimates of real per capita GDP growth. Table 3 presents summary statistics for the four performance indices, whose possible maximum values are all 250. The results suggest fairly similar distributions with the exception of Air, which has a significantly lower mean and greater variance. Our statistical results suggest that air pollution gets relatively low priority in poor countries but increases more rapidly in importance with income. By contrast, low income

countries such as Tanzania, Mozambique, Bhutan and Bangladesh seem to focus first on the natural resources which are critical to their livelihood -- soils, forests and water.

4. The Political Economy of Environmental Management

With the exception of research by Panayotou (1997) and a few others, empirical EKC studies have employed reduced-form regressions of air and water pollution indices on polynomial equations in income per capita. Statistical identification of an inverted-U relationship is generally rationalized as follows: In the early phase of development, environmental regulation is very weak or nonexistent and pollution-intensive industries grow rapidly. As countries approach middle-income status, some demand for environmental protection begins emerging. Industry begins to control its pollution at modest levels as regulations are enacted. At the same time, a shift toward services and less materials-intensive industries leads to a reduction in the generic pollution intensity of economic activity. Overall pollution begins leveling off, and then actually begins to decline as income-induced regulation, pollution control and structural change toward cleaner sectors become more significant.

These structural relations remain largely untested because of data scarcity. In this paper, we use our regulatory indices to test one key proposition of the EKC hypothesis: That environmental regulation is weak or non-existent until countries reach middle-income status, after which it rapidly becomes a significant factor in reducing pollution.

Table 2A
Sample Country Rankings:
Income and Environmental Performance Indices

Country	PCGNP	ICPGDP	Air	Water	Land	Living Resources	Total
Switzerland	01	01	02	02	2	01	02
Finland	02	03	04	03	3	04	04
Germany	03	02	01	01	1	02	01
Netherlands	04	04	03	04	4	03	03
Ireland	05	05	05	05	4	05	05
Korea	06	08	07	07	8	07	07
Trinidad	07	06	10	11	11	12	11
Brazil	08	10	12	16	16	15	15
S.Africa	09	09	08	09	9	10	9
Bulgaria	10	07	06	06	6	06	6
Jamaica	11	16	11	08	7	08	8
Tunisia	12	13	09	10	10	11	10
Thailand	13	11	15	24	18	23	19
Jordan	14	12	17	14	15	22	16
Paraguay	15	14	24	20	20	17	21
Papua NG	16	21	28	27	29	30	29
Philippines	17	17	18	24	20	18	20
Egypt	18	15	21	12	24	27	22
Zambia	19	26	22	23	20	20	23
Ghana	20	20	18	19	18	18	17
Pakistan	21	19	13	14	13	13	13
China	22	18	15	16	12	9	12
Kenya	23	24	23	16	16	16	18
India	24	23	13	13	14	14	14
Nigeria	25	22	26	21	25	24	24
Bangladesh	26	25	25	29	27	29	26
Malawi	27	27	18	22	23	21	27
Bhutan	28	30	30	31	30	28	30
Ethiopia	29	31	31	30	31	31	31
Tanzania	30	29	29	28	28	26	28
Mozambique	31	28	27	26	26	25	25

Table 2B
Sample Country Data:
Income and Environmental Performance Indices

Country	PCGNP ($1990)	ICPGDP (I$1990)	Air	Water	Land	Living Resources	Env
Switzerland	32,680	21,690	231	240	238	238	947
Finland	26,040	15,620	214	229	231	220	894
Germany	22,320	16,920	236	242	241	232	951
Netherlands	17,320	14,600	219	226	229	226	900
Ireland	9,550	9,130	203	223	229	216	871
Korea	5,400	7,190	150	170	189	177	686
Trinidad	3,610	8,510	118	149	159	138	564
Brazil	2,680	4,780	113	127	130	123	15
S.Africa	2,530	5,500	136	165	173	145	619
Bulgaria	2,250	7,900	168	198	199	185	750
Jamaica	1,500	3,030	114	168	193	158	633
Tunisia	1,440	3,979	128	158	161	142	589
Thailand	1,420	4.610	98	113	129	109	449
Jordan	1,240	4,530	95	131	138	110	474
Paraguay	1,110	3,120	84	117	123	119	443
Papua NG	860	1,500	54	91	100	84	29
Philippines	730	2,320	93	113	123	118	447
Egypt	600	3,100	92	134	118	97	441
Zambia	420	810	87	115	123	114	439
Ghana	390	1,720	93	124	129	118	464
Pakistan	380	1,770	105	131	144	128	508
China	370	1,950	98	127	151	153	529
Kenya	370	1,120	85	127	130	121	463
India	350	1,150	105	132	143	127	507
Nigeria	290	1,420	75	106	114	105	400
Bangladesh	210	1,050	77	89	109	91	366
Malawi	200	670	93	116	122	111	352
Bhutan	190	510	39	54	70	93	256
Ethiopia	120	310	20	56	67	75	218
Tanzania	110	540	50	90	103	98	341
Mozambique	80	620	56	98	112	102	378

Table 3

Indices of Environmental Policy: Summary Measures for 31 Countries

Resource	Mean	s.d.	Maximum	Minimum
Air	113.84	56.61	236.0	20.0
Water	140.61	50.91	242.0	54.0
Land	149.03	48.26	241.0	67.0
Living	137.84	46.70	238.0	75.0

Conceptually, our work does not differ from previous theoretical offerings. Pollution-generating activities adversely affect national welfare by damaging human health, economic activities and ecosystems. Because environmental problems represent a classic externality, some government regulation is generally warranted. From an economist's perspective, desirable regulation should weigh two factors: the benefits associated with reduced environmental damage and the opportunity cost of mitigation. In reality, the extent and focus of government intervention will also reflect national political and institutional considerations.

4.1 Benefits

The demand for environmental quality should increase with income per capita, and we would expect this to be strongly reflected in our country scores. However, we recognize that the regulatory response will depend on actual environmental degradation. If environmentally benign activities are the main sources of growth in an economy, then we may observe little or no relationship between income and regulation. In addition, demographic and sectoral differences may play an important role. For example, economies with high rural population densities and heavy dependence on agriculture and forest extraction should be particularly concerned with

agricultural water supply, soil erosion, and deforestation. In our Evaluation Format (Table 1), the relevant scoring cells are located at the intersection of Agriculture with Water, Land and Living Resources.[3] If environmental policy reflects basic economic considerations in resource-dependent economies, we would expect country scores in these dimensions to be positively correlated (ceteris paribus) with rural population density and the share of agricultural and forest production in national output.

By contrast, urbanized and industrialized economies should exhibit more concern with the potential health impacts of air and water pollution in densely populated areas. The relevant cells in this context are located at the intersections of the Air and Water columns with Industry, Energy, Transport and Urban. We would expect country scores in these dimensions to be correlated with the urban share of national population, urban population density, and the share of manufacturing in national output.

4.2 Opportunity Costs

Governments must make resource allocation decisions with constrained budgets, so we would expect the benefits of environmental improvement to be weighed against opportunity costs. In particular, environmental management has to share a limited social welfare budget with public health, education and other needs. Therefore the poorer the country, the more limited environmental management resources are likely to be. This should be another source of positive correlation between income per capita and country scores for regulation.

4.3 Political Economy

Political and institutional factors may also contribute significantly to cross-country

[3] Agriculture includes wood production from plantations and primary forests.

variation in environmental policy and performance. Attention to environmental problems should reflect the political power of affected interest groups, the quality of their information about environmental damage, and the effectiveness of legal and regulatory institutions. Most environmental problems pit broad public interests against the profitable pursuit of manufacturing and extraction. Thus, we might expect our environmental performance indices to be correlated with measures of the degree of popular representation, freedom of information and education. Performance should also be superior where legal and regulatory systems are relatively efficient. Finally, environmental objectives may be promoted more strongly in economies where secure property rights lead to longer planning horizons.

4.4 Predicted Relationships

Within this simple framework, we can make some predictions about the probable strength and direction of empirical relationships across our sample countries. We consider three sets of indices: Overall policy and performance scores for Air, Water, and Land; a "Green" index (interaction of Agriculture with Water, Land and Living Resources) and a "Brown" index (interaction of Industry, Energy, Transport and Urban with Air and Water). We have also decomposed the Green and Brown indices into three subindices: Awareness of environmental problems; enactment of regulations; and success in implementation. However, as Table 4 indicates, the subindices are so highly correlated that more detailed analysis seems unnecessary.

Table 4
Correlation Matrices: Component Scores

Green Subindices

	Composite	Awareness	Enactment	Success
Composite	1			
Awareness	.906	1		
Enactment	.982	.858	1	
Success	.968	.866	.910	1

Brown Subindices

	Composite	Awareness	Enactment	Success
Composite	1			
Awareness	.953	1		
Enactment	.989	.926	1	
Success	.984	.934	.951	1

To summarize briefly:

1. Overall, unless all the dominant growth sectors are environmentally benign, measures of environmental regulation should be positively correlated with:

   1) Income per capita;
   2) Degree of popular representation;
   3) Freedom of information;
   4) Security of property rights;
   5) Development of the legal and regulatory system.

2. Controlling for these variables,

   Green indices should be positively correlated with:

   1) Rural population density;
   2) Agricultural and forest production share of national output.

Brown indices should be positively correlated with:

1) Particular focus on public health, indexed by life expectancy[4];
2) Urban share of total population;
3) Population density;
4) Manufacturing share of national output.

5. Results

5.1 Income and Environmental Performance

Our results do not appear to reveal any instance of growth based predominantly on 'environmentally benign' sectors. The correlation between income and composite environmental policy rankings is clear in Table 2A. In bivariate regressions on the two income measures, recorded in Tables 5A and 5B, the income elasticity of environmental regulation is positive and highly significant in all environmental dimensions. The statistical fit is somewhat better when income is adjusted for purchasing power parity. Regulation of air pollution seems to have a higher income elasticity than the others. The scatter of the composite environmental index against ICPGDP (Figure 1) shows that the relationship is continuous over the entire range of incomes. In summary, our evidence strongly contradicts the view that countries must reach middle-income status before environmental regulation begins.

Inspection of regression outliers among developing countries reveals that India, Malawi and Jamaica have much higher scores than their incomes would predict, while Thailand, Ethiopia and Bhutan have lower-than-predicted scores. A more detailed analysis of outlier country experience (see Appendix A) suggests that environmental performance improves noticeably

[4] We recognize some risk of endogeneity, but we regard it as minimal in this case. Life expectancy is influenced by many policy and other variables which are not directly related to environmental concerns.

when

the government integrates environmental management with development planning. The relatively superior performance of India, Jamaica and Malawi (as opposed to Thailand, Bhutan and Ethiopia) may be partly due to early movement on environmental policy, government focus on a few strategic issues, and active participation of communities in environmental management.

Table 5A

Impact of PCGNP on Environmental Indicators*

Dependent Variable	Intercept	ln PCGNP	Adjusted R^2
ln Air	2.70 (11.93)	0.27 (8.70)	0.71
ln Water	3.55 (22.84)	0.19 (8.80)	0.72
ln Land	3.79 (27.70)	0.17 (8.75)	0.72
ln Living	3.73 (29.60)	0.16 (9.26)	0.74
ln Env	4.89 (34.80)	0.19 (9.78)	0.76

* *t*-statistics in parentheses.

5.2 Political Economy

For the reasons previously noted, effective environmental management may be seriously handicapped by lack of political, civil, and economic liberty; lack of an independent judicial system; and an inefficient or corrupt bureaucracy. To test these ideas, we have fitted regressions with several sets of institutional indicators previously used in the literature. In each case, limited availability of the indicators has forced us to run regressions on subsamples of countries.

Table 5B

Impact of ICPGDP on Environmental Indicators

Dependent Variable	Intercept	ln ICPGDP	Adjusted R^2
ln Air	1.29 (4.06)	0.42 (10.59)	0.79
ln Water	2.59 (11.53)	0.30 (10.30)	0.78
ln Land	2.97 (14.52)	0.25 (9.82)	0.76
ln Living	3.03 (13.88)	0.23 (8.53)	0.71
ln Env	3.97 (18.72)	0.29 (10.79)	0.79

The first of these is a widely used set of political, civil and economic liberty indicators developed by Gastil.[5] These indicators are available for 29 of our 31 countries. Among the most relevant variables for our study are freedom of property (FOP), freedom of information (FOI), freedom of print media (FPM), freedom of broadcast media (FBM), freedom of peaceful assembly (FPA) and the Gastil-Wright typology of economic systems (TES). In our regressions, only FOP and FOI are statistically significant (Table 6). Each of these indicators is coded 1 to 5, with higher scores for lower liberty, so the expected sign of the coefficients is negative for both indicators. Freedom of property has the expected sign, but the other result is quite surprising: Freedom of information is negatively associated with the environmental indices, ceteris paribus.

[5] See Scully (1992) for details.

Table 6

Impact of Liberty Indexes on Environmental Indicators

Dependent Variable	Intercept	ln ICPGDP	ln FOP	ln FOI	Adjusted R^2
ln Air	1.42 (2.97)	0.41 (8.17)	-0.36 (-2.39)	0.27 (2.24)	0.80
ln Water	2.86 (9.54)	0.27 (8.44)	-0.26 (-2.80)	0.18 (2.38)	0.82
ln Land	3.17 (10.28)	0.23 (7.16)	-0.18 (-1.90)	0.12 (1.57)	0.77
ln Living	3.22 (9.57)	0.22 (6.27)	-0.27 (-2.57)	0.16 (1.90)	0.74
ln Env	4.18 (13.43)	0.27 (8.25)	-0.26 (-2.72)	0.18 (2.25)	0.82

As a second test, we have employed measures of bureaucratic delay, nationalization risk and contract enforceability from Business Environmental Risk Intelligence, Inc. (BERI).[6] Scores for the BERI indicators are available for only fourteen of our thirty-one countries and are set so that positive relationships with environmental management would be consistent with our prior hypothesis. The regression coefficients are positive, as expected, but none are statistically significant (Table 7).

Finally, we have tested indicators that reflect the efficiency of the legal and judicial system (LJS) and red tape in the bureaucracy (RTB). These were developed by the Country Assessment Service of Business International, Inc.[7] Unfortunately, the measures are available for

[6] For a discussion of these indicators, see Keefer and Knack (1993).

[7] See Wheeler and Mody (1992) for details.

only twelve of the thirty-one countries in our sample. In separate regressions for this subset of countries, both LJS and RTB emerge as significant explanatory variables. Since they are collinear, we have also computed their first principal component (PC1) and used it as a composite regressor. When it is included with ICPGDP (Table 8) the results show substantial improvement in the explanatory power of the regressions. The change in outliers indicates that the improvement is especially striking for Ireland, India and Thailand.

5.3 Green and Brown Indices

For both Green and Brown indices, performance is again strongly associated with income per capita, freedom of property and (in small samples) measures of regulatory efficiency. The two rural-sector variables (population density; proportion of GDP in agriculture and forestry) are only weakly associated with the Green index (Table 9a). The fit is much better for the Brown index: degree of urbanization, population density and manufacturing share in GDP all have the expected signs and relatively high significance (Table 9b). Life expectancy as a proxy for public health priority has no independent effect

6. Summary

Using a multidimensional survey analysis of UNCED reports, we have developed a set of comparative indices of environmental policy in thirty-one countries. We use these indices to analyze an important component of the EKC model: the relationship between development and environmental regulation. Our results do not support the conventional assumption that environmental regulation only emerges in the middle stage of development. Instead, we find a

Table 7

Impact of BERI Indexes on Environmental Indicators

Dependent Variable	Intercept	ln ICPGDP	ln Delay	ln Contract	Adjusted R^2
ln Air	1.99 (3.48)	0.32 (3.23)	0.19 (0.56)		0.81
ln Water	3.21 (6.19)	0.18 (2.04)	0.31 (1.00)		0.72
ln Land	3.25 (6.18)	0.20 (2.19)	0.18 (0.57)		0.68
ln Living	2.99 (4.87)	0.21 (1.99)	0.24 (0.64)		0.66
ln Env	4.29 (7.96)	0.22 (2.40)	0.23 (0.72)		0.74
ln Air	2.05 (2.24)	0.32 (2.10)		0.16 (0.34)	0.81
ln Water	3.45 (4.15)	0.15 (1.11)		0.35 (0.82)	0.72
ln Land	3.43 (4.12)	0.18 (1.26)		0.22 (0.52)	0.68
ln Living	3.01 (3.06)	0.22 (1.34)		0.17 (0.33)	0.65
ln Env	4.42 (5.13)	0.21 (1.47)		0.23 (0.52)	0.73

Table 8

Impact of ICPGDP, LJS and RTB on Environmental Indicators

Dependent Variable	Intercept	ln ICPGDP	PC1	Adjusted R^2
ln Air	1.60 (2.91)	0.38 (6.02)		0.76
ln Air	3.35 (8.81)	0.18 (4.07)	0.26 (6.18)	0.95
ln Water	2.59 (5.57)	0.29 (5.35)		0.72
ln Water	4.13 (16.68)	0.11 (3.73)	0.23 (8.37)	0.96
ln Land	2.79 (6.19)	0.27 (5.16)		0.70
ln Land	4.20 (13.15)	0.10 (2.78)	0.21 (5.96)	0.93
ln Living	2.79 (6.19)	0.27 (5.16)		0.70
ln Living	4.05 (9.12)	0.11 (2.15)	0.24 (4.91)	0.90
ln Env	3.77 (7.79)	0.31 (5.48)		0.73
ln Env	5.35 (18.08)	0.12 (3.58)	0.23 (7.15)	0.95

continuous relationship between regulation and national income per capita. In our regressions we get a better fit when national incomes are adjusted for purchasing power parity. The income elasticities of our indicators are positive and highly significant in all environmental dimensions. Our results suggest that protection measures for land and living resources precede those for water; action for reducing air pollution comes later. Available indices of Green sector importance have no measured effect on Green performance, but the corresponding Brown sector variables do have significant explanatory power. Overall, the regression fits are quite good.

The apparent effectiveness of institutional quality is also striking, although our information base is limited. The level of explanation in all regressions improves significantly when effectiveness of the legal/judicial system and efficiency of bureaucracy are included. To our surprise, however, none of the other plausible political economy measures seems to account for much.

In summary, our findings suggest that a detailed, quantified analysis of UNCED reports can yield comparable and plausible indices of environmental policy and performance across countries. Our results also suggest that knowledge of a country's income per capita and general administrative efficiency are sufficient to predict the status of environmental regulation with considerable accuracy. Finally, our results suggest that countries begin paying attention to environmentally-damaging activities long before they reach middle-income status.

Table 9a
Regression Results for ln (Green)*

Intercept	ln PCGNP	ln ICPGDP	ln FOP	ln (Share of Agriculture in GDP)	ln (Pop. Density)	Adjusted R^2
3.31 (25.55)	0.16 (8.66)					0.71
2.60 (12.29)		0.23 (8.65)				0.71
2.75 (4.69)		0.20 (3.85)	-0.11 (-1.31)	0.06 (0.93)	0.09 (1.32)	0.64
3.27 (11.11)		0.17 (5.38)	-0.16 (2.19)		0.09 (1.34)	0.73

Table 9b
Regression Results for ln (Brown)*

Intercept	ln PCGNP	ln ICPGDP	ln FOP	ln (Urban /Total Pop.)	ln (Pop. Density)	ln (Manuf Share)	ln (Life Expectancy)	Adj R^2
3.81 (24.25)	0.21 (9.75)							0.76
2.73 (12.40)		0.32 (11.75)						0.82
3.91 (2.63)		0.20 (2.27)	-0.19 (1.98)	0.14 (1.46)	0.06 (2.30)	0.16 (2.04)	-0.34 (-0.67)	0.82
2.94 (8.02)		0.16 (2.65)	-0.20 (2.20)	0.14 (1.46)	0.06 (2.25)	0.15 (1.95)		0.83

Table 9c
Green/Brown Impacts of ICPGDP, FOP and Regulatory Efficiency*

Variable	Intercept	ln ICPGDP	ln FOP	ln RTB	ln LSJ	AdjR^2
ln (Green)	3.84 (9.37)	0.03 (0.52)	-0.17 (1.83)	0.39 (3.37)		0.93
ln (Brown)	3.95 (9.44)	0.09 (2.69)	-0.07 (1.09)	0.36 (4.20)	0.14 (1.07)	0.98

*t-statistics in parentheses

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APPENDIX A

THE OUTLIERS

Positive Outliers:

1) India had environmental legislation relatively early. The National Council of Environmental Planning and Coordination was set up in 1972 to identify and investigate the problems of preserving and improving the human environment, and to propose solutions to environmental problems. Many collaborative programs addressing environment and development issues have been established by the government and NGO's. The National policy on Education, 1986, has a master plan for universal provision of facilities for environmental education. The government has announced a comprehensive pollution abatement policy that seeks to combine regulation with fiscal incentives, encourage adoption of clean technology and promote public participation.

2) Malawi established an environmental education unit in 1972. Government measures to promote women's role in development also focus on environmentally-relevant issues: sanitation, safe water and community participation.

3) Jamaica has a vibrant NGO community that is heavily involved in environmental activities. Past and present capacity-building initiatives in environmental management and sectoral integration include: development of linkages with the private sector and NGO's in public-sector investment programs; creation of an inter-agency technical committee on environmental issues; integration of national environmental objectives into sectoral planning and decision-making; and development of general guidelines by the National Resources Conservation Authority to inform the planning and policy decisions of sectoral agencies.

Negative Outliers:

1) Thailand has promoted rapid economic development but seems to have permitted an unsustainable level of natural resource exploitation. Although a number of regulatory statutes exist (relating to forestry, industry and water resources) monitoring, compliance checking and enforcement have been weak.

2) In Ethiopia, the effects of war and drought left over eight million people victims to food shortages and displacement. Inadequate health and education systems were other major problems, and so far there has been a near-complete neglect of environmental concerns.

3) Bhutan: The normal diffusion of environmental awareness from developed to developing countries seems to have been hampered by Bhutan's relative isolation. Only recently has a modern system of laws, policies and regulations been developed.

APPENDIX B

QUESTIONNAIRE FOR EVALUATING ENVIRONMENTAL POLICY
[Status: H (High); M (Medium); L (Low)]

1. AWARENESS

   A. When did environmental awareness gain prominence?

      H Pre 1972
      M 1972-89
      L 1990+

   B. How widespread is this awareness at present?

      H Mass awareness countrywide
      M Restricted to limited pockets of elite groups
      L Very little awareness

   C. The extent of awareness regarding global dimensions

      H Excellent
      M Reasonable
      L Very little

2. POLICY

   A. For how long has significant environmental policy existed?

      H Dates back to 1970's
      M Introduced in the last ten years
      L Very little so far

   B. How did the policy evolve?

      H As a felt need
      M Of late as a result of diffusion of knowledge
      L Yet to evolve significantly

   C. What is the coverage of the policy?

      H Comprehensive with clearly laid down targets
      M Some policy and some targets
      L Very little policy

3. LEGISLATION

A. When did significant environmental legislation begin to be enacted?

H Dates back to 1970's
M Introduced in the last ten years
L Very little so far

B. How extensive is the legislation so far?

H Comprehensive and supported by detailed rules and regulations
M Sketchy; some rules and regulations
L Only a few laws or none at all

C. What is the extent of machinery for enforcement of laws?

H Agency clearly entrusted with specified guidelines
M Agency set up but yet to develop effectively
L No agency or very little effort so far

4. CONTROL MECHANISM

A. What is the nature of regulatory instruments?

H Both command and control and economic
M Only command and control
L Hardly any mechanism

B. What is the extent of power vested in the environmental protection agency?

H Both formulation of policy and enforcement
M Limited to policy
L No agency or very little power

C. What is the degree of decentralization of the agency?

H Extensive
M Somewhat
L Very little

D. What is the extent of allocation of funds to the agency?

H Reasonably good for carrying out allotted tasks
M Some but not enough for effective functioning
L None or very little

E. What is the extent of self-regulation by polluters?

H Extensive
M Somewhat
L Very little

F. How widespread is the involvement of NGO's in regulation?

H Extensive
M Somewhat
L Very little

G. What is the progress of preparation of a national environmental action plan (NEAP)?

H NEAP with detailed plans for identifiable regions has been prepared
M Only a sketchy NEAP or plans for some regions
L No action so far

5. MEASURE OF SUCCESS

A. What is the trend in environmental indicators?

H Improving
M Not much headway but steady
L Deteriorating

B. Roughly what percentage of GDP is devoted to environmental control measures?

H More than 1%
M Some but less than 1%
L Almost none

C. What is the market share of pollution control industries in total industrial production?

H Above the global average
M Around average
L Below average

D. What is the prevalence of environmental incidents/accidents?

H Almost none
M A few
L Considerable

E. How good is the availability of environmental data?

H Extensively compiled
M Sporadically available
L None or very little

F. What is the extent of interest in environmental studies and R & D?

H Widespread
M Somewhat
L None or very little

G. How widespread is the involvement of NGO's in the environmental movement?

H Considerable
M Somewhat
L None or very little

H. What is the prevalence of environmental litigation?

H Considerable
M Somewhat
L None or very little

I. What is the level of media interest in environmental issues?

H Very high
M Somewhat
L None or very little